NOTES ON THE BIOLOGY OF *SCELIODES CORDALIS* (DOUBLEDAY) (LEPIDOPTERA: CRAMBIDAE)

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Abstract

Sceliodes cordalis (Doubleday) is an important pest of eggplant but little is known of its biology. Egg size, oviposition sites, seasonal occurrence and egg parasitism were studied from 2006 to 2008 in the coastal Burnett district of Queensland. Eggs (L:W:H :: 0.716 mm: 0.445 mm: 0.292 mm) were laid predominantly on the calyx of the fruit but not on flowers. *Trichogramma* Westwood and *Trichogrammatoidea* Girault wasps emerged from parasitised eggs. Pheromone traps caught moths throughout the year, with higher catches in spring and summer than in winter and in the presence of eggplant crops.

Introduction

In Australia, the eggfruit caterpillar, *Sceliodes cordalis* (Doubleday), is an important pest of eggplant (*Solanum melongena* L.) and an occasional pest of tomatoes (*Lycopersicon esculentum* Miller) and capsicums (*Capsicum annuum* L.) (Davis 1964). It also occurs in New Zealand, where it is a serious pest of pepinos (*Solanum muricatum* Aiton) (Galbreath and Clearwater 1983). Davis (1964) provided a general description of the insect, its biology and the damage it causes to eggplant; the neonate larva bores into the fruit, tunnelling extensively as it develops and emerging when ready to pupate. Kay (2010) reported the effect of constant temperatures on the development of *S. cordalis* and listed references to studies on its pheromone, pathogens, insecticidal control and seasonal occurrence in New Zealand.

Further information on the biology of *S. cordalis*, gathered during a study of its management in the coastal Burnett district of Queensland, based around the city of Bundaberg (24°54'S, 152°22'E), is reported here. The size of *S. cordalis* eggs, their location on the fruit, egg parasitism and the seasonal occurrence of *S. cordalis* are discussed.

Methods

Egg size

The length and width of 20 eggs laid on gauze material in the laboratory and of 20 eggs laid on the calyx of fruit in the field were measured using a calibrated eyepiece graticule in a Leica Wild M8 binocular microscope at 25 times magnification. Length was measured from end to end and width at the mid point of the eggs. It was not possible to accurately measure the height of the eggs from the base to the top of the longitudinal ridge, but it was attempted for nine field-collected eggs. The measurements of the laboratory and field eggs were compared with t-tests using GenStat Release 11.1.

Egg location

During 2006-2007, 1422 fruit were collected from commercial eggplant crops and unsprayed trial plots. They were examined under low

magnification in the laboratory using a Maggylamp, with the location and number of eggs recorded. In addition, 50 flowers and 50 very young fruit, with the calyx lobes still extending to the tip of the fruit, were collected a week apart from the same crop and examined for the presence of eggs.

Parasitism

Black, parasitised eggs were found occasionally on sampled fruit. These eggs were cut carefully from the fruit on a small piece of plant tissue and held in the laboratory until the parasitoids emerged. Parasitoids were identified as either *Trichogramma* Westwood sp. or *Trichogrammatoidea* Girault sp. (Hymenoptera: Chalcidoidea: Trichogrammatidae), based on the length of the marginal hairs on the forewing. Several of the *Trichogramma* sp. specimens were sent to Dr Linda Thomson, University of Melbourne, for identification.

Seasonal occurrence

Green AgriSense™ funnel traps, baited with *S. cordalis* pheromone lures (500 µL of pheromone impregnated in a 20 mm length of rubber septum) and with the base section of the trap lined with a sticky insert to retain trapped moths, were placed beside eggplant crops at five sites in the coastal Burnett district. Two traps, hung 1 m above the ground, were used at each site. The traps were monitored fortnightly and the numbers of moths recorded. Pheromone lures were replaced every four weeks and the inserts replaced as necessary. The study ran from August 2006 to December 2008.

Results

Egg size

The mean lengths and widths of laboratory and field eggs and for the two combined and the approximate height of eggs are shown in Table 1. The mean lengths and widths of laboratory and field eggs did not differ significantly (length $t = 0.05$, 30 df, $P = 0.964$; width $t = 0.17$, 38 df, $P = 0.865$).

Table 1. The mean length and width and approximate height of *S. cordalis* eggs. (n = number of eggs).

Source of eggs	Length (mm) Mean ± SD (n)	Width (mm) Mean ± SD (n)	Height (mm) Mean ± SD (n)
Laboratory	0.716 ± 0.024 (20)	0.444 ± 0.037 (20)	-
Field	0.716 ± 0.043 (20)	0.446 ± 0.054 (20)	0.292 ± 0.029 (9)
Combined	0.716 ± 0.034 (40)	0.445 ± 0.046 (40)	-

Egg location

Eggs were recorded on the calyx, the basal third of the fruit (adjacent to the calyx), the middle third or the apical third of the fruit. Two hundred and thirty eight eggs were found on 153 fruit. The proportion of eggs on the fruit was: calyx 97.9% (233 eggs); basal third 0.4% (1); mid third 0.8% (2); apical

third 0.8% (2). Both of the eggs found on the mid section of the fruit were on thrips-feeding or wind-rub scars and the two eggs on the apical section were on the flower scars. Table 2 shows the numbers of eggs recorded on each fruit. No *S. cordalis* eggs were found on the flowers but eggs were found on 10% of the very young fruit. *Helicoverpa* Hardwick spp. (Lepidoptera: Noctuidae) eggs were found on 62% of the flowers.

Table 2. The number of eggs on each infested fruit. Eggs were found on 153 fruit.

	Number of eggs on each fruit					
	1	2	3	4	5	10
% of fruit	66.0	21.6	8.5	2.0	1.3	0.7

Parasitism

Parasitoid wasps were reared from 21 eggs. *Trichogramma* sp. was reared from 11 of the eggs, with usually two but occasionally one wasp per egg, and *Trichogrammatoidea* sp. was reared from 10 eggs, with from one to three, usually two, wasps per egg. Morphological and molecular examination of the *Trichogramma* specimens sent to Dr L. Thomson could not establish their specific identity. Gel electrophoresis following PCR amplification of the ITS-2 region (Thomson *et al.* 2003) demonstrated that the wasps were not the introduced *Trichogramma pretiosum* Riley (L. Thomson pers. comm.).

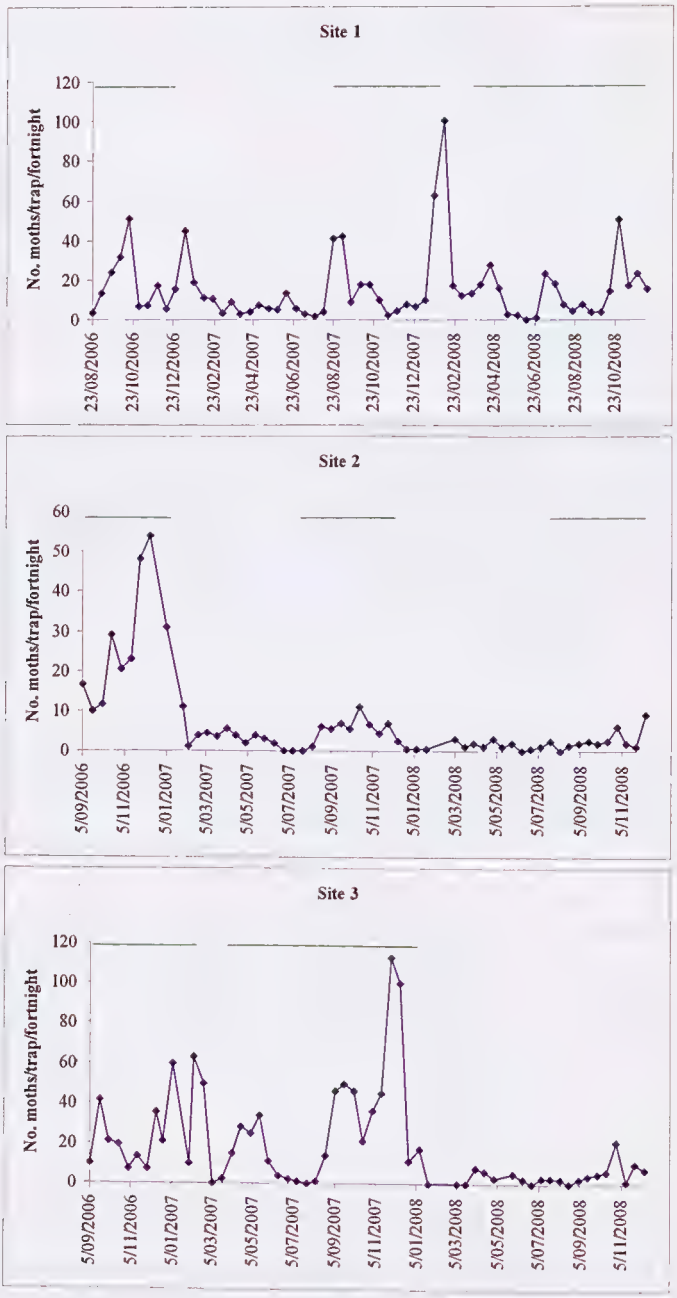
Seasonal occurrence

Figure 1 shows the fortnightly catches of *S. cordalis* moths at each of the five sites. Moths were trapped throughout the year at all sites, with catches generally highest in spring and summer months (September-February) and lowest in winter (June-August). Generally, catches were higher when eggplant crops were grown close to the traps.

Discussion

Davis (1964) described *S. cordalis* eggs as 'a flattened dome like an upturned shallow oval basin, about half as wide as long and with a low ridge running down the middle' and estimated the length as 'about one fortieth of an inch long' [approximately 0.635 mm]. The eggs are an elongated oval shape, with almost parallel sides and rounded ends. Their length (0.716 mm) is slightly longer than estimated by Davis (1964) and their width (0.445 mm) a little more than half the length. It was not possible to accurately measure the height of eggs as it was not possible to remove them undamaged from the surface on which they were laid, but they are about 0.29 mm high.

Most of the eggs (98%) were laid on the calyx and the remainder on scar tissue on the fruit, indicating that the moths prefer to oviposit on rough surfaces. However, although the eggs are firmly attached to the surface, it is possible that eggs laid on the smooth skin of the fruit may have been dislodged as the fruit were harvested and transported from field to laboratory.


Site 1
No. moths/trap/fortnight
120
100
80
60
40
20
0
23/08/2006
23/10/2006
23/12/2006
23/02/2007
23/04/2007
23/06/2007
23/08/2007
23/10/2007
23/12/2007
23/02/2008
23/04/2008
23/06/2008
23/08/2008
23/10/2008
Site 2
No. moths/trap/fortnight
60
50
40
30
20
10
0
5/09/2006
5/11/2006
5/01/2007
5/03/2007
5/05/2007
5/07/2007
5/09/2007
5/11/2007
5/01/2008
5/03/2008
5/05/2008
5/07/2008
5/09/2008
5/11/2008
Site 3
No. moths/trap/fortnight
120
100
80
60
40
20
0
5/09/2006
5/11/2006
5/01/2007
5/03/2007
5/05/2007
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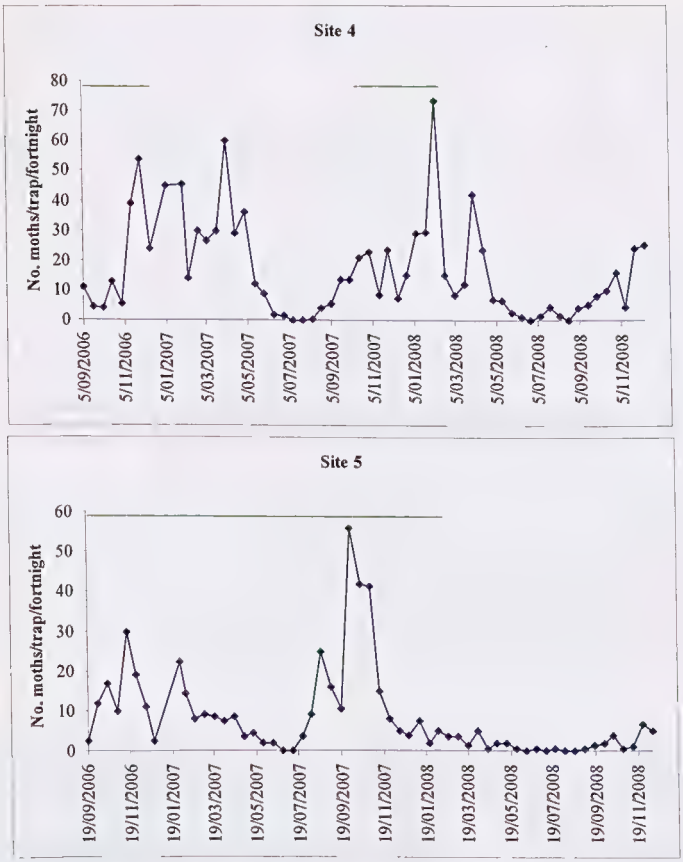


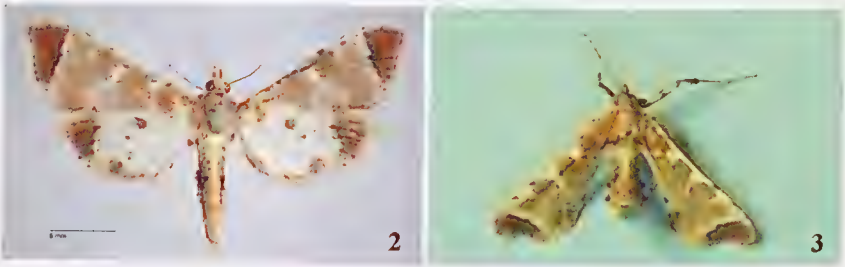
Fig. 1. Numbers of *S. cordalis* moths trapped each fortnight at each of the five sites. Numbers are the mean of the catches of the two traps at each site, except for Site 3, where a single trap was used from April 2007 onwards. Green lines (——) indicate the presence of eggplant crops near the traps.

Davis (1964) also reported that eggs were usually laid on the calyx. Usually, there were only one or two eggs on each fruit (Table 2) and normally only one or two larvae are found in infested fruit (I. Kay pers. obs.). The presence of eggs on very young fruit but not on flowers indicates that moths are not attracted to the host to oviposit until fruit are present and that there is the potential for fruit to be infested very early in their development.

Both *Trichogramma* sp. and *Trichogrammatoidea* sp. adults were reared from black *S. cordalis* eggs, which were quite common in unsprayed trial crops. While the parasitoids have not been identified to species, it is interesting that the *Trichogramma* sp. was not *T. pretiosum*, a generalist egg

parasitoid (Brotodjojo and Walter 2006) that was first released in the Bundaberg district in about 2000 and is now the dominant species parasitising eggs of *Helicoverpa* spp., having displaced a dark *Trichogramma* sp. and several *Trichogrammatoidea* spp. (probably *Trichogrammatoidea bactrae* Nagaraja and *T. robusta* Nagaraja), which had parasitised up to 92% of *Helicoverpa* spp. eggs in 1996 and 1997 (Kay 1999). It would appear that *T. pretiosum* has not extended its host range to include *S. cordalis* eggs.

Pheromone traps caught *S. cordalis* moths at all times of the year. Catches were higher during the warmer months of the year and when eggplant crops, their major commercial host, were growing close to the traps. Moths (Figs 2-3) were trapped in the absence of eggplant crops, or other commercial hosts, so presumably other solanaceous hosts such as *Datura* spp. allowed breeding to continue. Catches generally were low during the winter months (June-August), even when eggplant crops were nearby (*e.g.* Sites 1, 3 and 5), although some moths were trapped. The lower winter temperature would result in longer developmental times and so fewer moths would be present at any time. Also, it is possible that a proportion of the population may have overwintered in diapause. In New Zealand, *S. cordalis* overwinters as diapausing larvae in cocoons (Martin 1999) and Kay (2010) reported that several larvae from a Bundaberg laboratory colony reared at 20° C and 12:12 L:D entered diapause. Further studies are needed to determine whether *S. cordalis* does enter diapause in the Bundaberg district and the factors responsible for diapause induction and termination.



Figs 2-3. Adults of the eggplant caterpillar, *Sceliodes cordalis* (Doubleday): (2) pinned adult; (3) live adult in resting pose.

Acknowledgements

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